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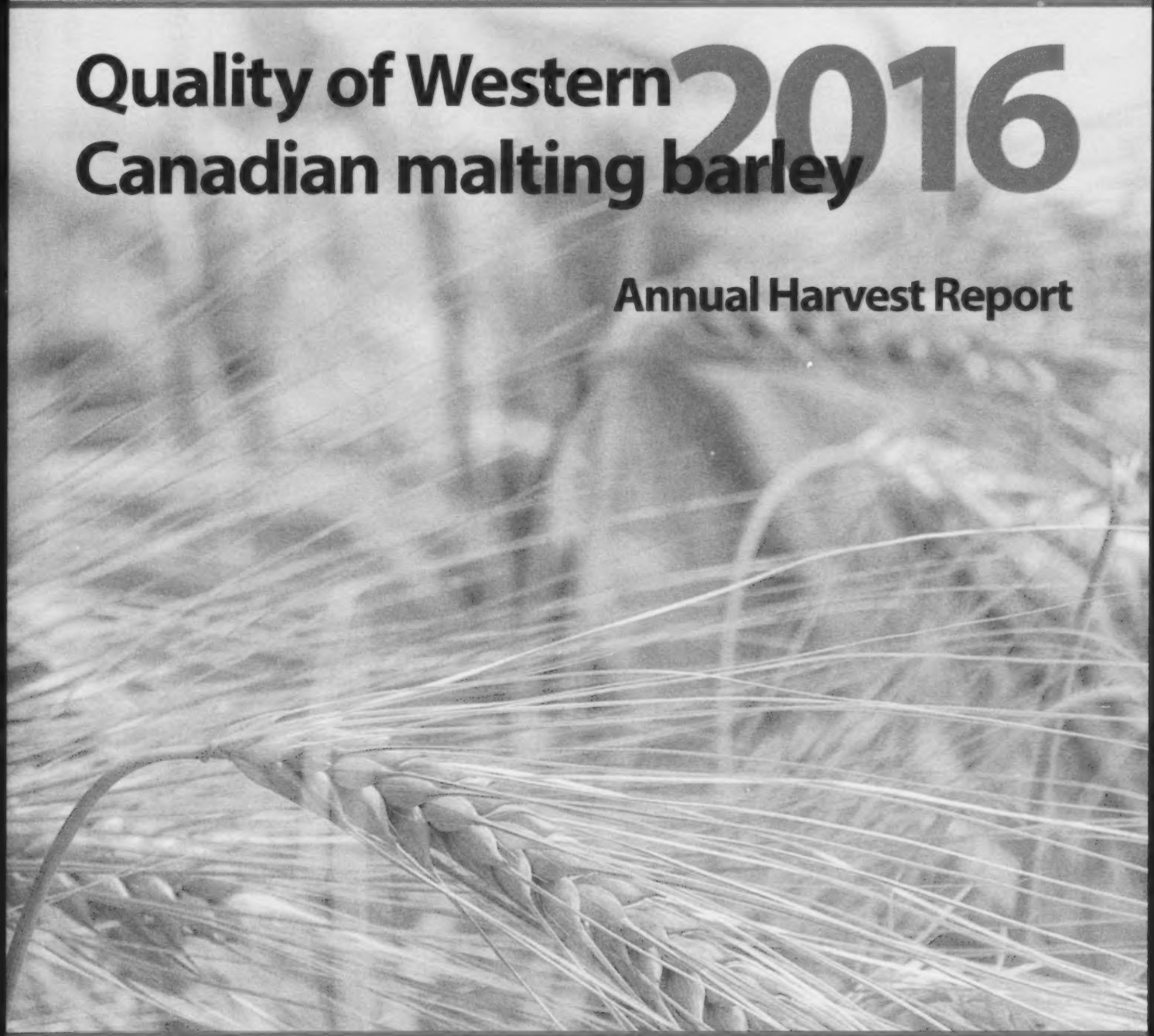
Quality of Western Canadian malting barley 2016

Annual Harvest Report



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Summary

Total barley production in Western Canada in 2016 is estimated at 8,371,500 tonnes, which represents an increase of about 7.5% compared to 2015. The higher barley production in 2016 compared to 2015 was due to very high yields this year, assessed at 73.9 bushels per acre. Barley seeded area in 2016, estimated at 2,465,000 hectares, decreased by 1.9% compared to 2015.

Dry and warm conditions during April and early May of 2016 resulted in rapid planting progress; nearly 60 % of the barley was planted by the second week of May, well ahead of the normal pace. Average temperatures and above average precipitation characterized the 2016 growing season across Western Canada. The above normal rainfall through July and August increased disease potential in the barley crop. Fusarium head blight was a common downgrading factor in barley grown in many regions in 2016. The barley harvest started in August and was nearly 30% complete by the beginning of September. Record or near record rainfall amounts were received in Saskatchewan and northern Alberta during the months of September and October. These rains caused serious quality deterioration in the un-harvested barley crop.

The 2016 barley harvest survey conducted by the Grain Research Laboratory and the Canadian Malting Barley Technical Centre (CMBTC) was based on composites of individual varieties representing one million tonnes of barley selected in Western Canada for malting by grain handling and malting companies.

Overall, the quality of barley that was selected for malting in 2016 was good with lower than average protein levels in barley grain, and heavier and plumper kernels compared with the 10-year average values. Barley germination was adequate; however, some water sensitivity was present. RVA (rapid visco analysis) indicated high incidence of pre-harvest sprouting which prompts timely processing of barley into malt.

Malt made from 2016 barley resulted in very high extract levels exceeding the long-term average values. Wort was characterized by lower than average levels of soluble proteins, free amino nitrogen (FAN), and colour, slightly higher than average levels of β-glucans, but acceptable viscosity. The brewing trials conducted by the CMBTC indicated that malts made from CDC Copeland and AC Metcalfe performed satisfactorily without posing any processing difficulties.

Part 1- Growing and Harvesting Conditions in 2016

There was a wide range of moisture regimes present in Western Canada in the fall of 2015. The primary feature was a substantial difference between the soil moisture situation in western Saskatchewan and Alberta and the eastern areas of the Prairies. The western areas of the Prairies were coming off of a drought in 2015 and dry soil moisture levels were reported throughout the region. The exception was a portion of central Alberta, which had received additional rainfall during the fall of 2015. The soil moisture situation in the eastern areas was mostly adequate to surplus. The main concern in the eastern regions centered on the potential for planting delays if winter precipitation was above normal. Fortunately for the eastern growing areas, the winter of 2015-16 was mild and drier than normal. The northern growing areas of Saskatchewan were the exception as this region received normal to slightly above normal precipitation during the winter months.

Dry and warm conditions during April and early May of 2016 (Fig.1.1) resulted in rapid planting progress which exceeded the both the normal pace and the rapid progress of the 2015 crop year. Nearly 60 per cent of the barley was planted by the second week of May, which was well ahead of normal. Some of the driest areas of Alberta delayed seeding due to dry moisture conditions, which slowed barley plantings through the end of May.

Figure 1.1 Mean temperature differences from normal for May 2016

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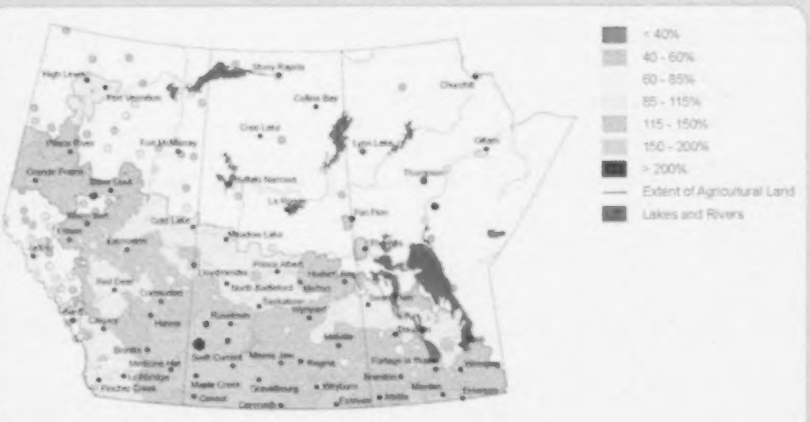
Figure 1.2 Percent of average precipitation (Prairie Region) from April 1 to September 25, 2016



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Normal temperatures and above normal precipitation (Fig. 1.2) characterized the 2016 growing season across Western Canada, with most of the western dry areas receiving beneficial moisture by the middle of June. The above normal rainfall continued through July and August, which increased disease potential in the barley crop. Fusarium head blight was a common downgrading factor in barley grown in the eastern regions in 2016.

The barley harvest began in August and was nearly 30% complete by the beginning of September. Record or near record rainfall amounts were received in Saskatchewan and northern Alberta during the months of September and October. These rains caused serious quality deterioration in the un-harvested barley crop. Harvest progress during this period was very slow, although it did manage to reach close to 85% complete by the end of October. Downgrading of the crop due to weathering factors was present in the later harvested crop. Mild, dry weather returned to the Prairie region in early November resulting in some harvest progress, but there still remains a portion of the crop to be harvested in the early winter or spring.

Part 2 - Barley Production in 2016

2.1 Annual statistics

The total area planted with barley in Western Canada in 2016 was 2.465 million hectares, indicating a slight decrease (1.9%) compared to the 2015 acreage (Table 2.1). However, the production of barley in Western Canada in 2016, estimated at about 8.4 million tonnes, was about 7.5% higher than in 2015 (Table 2.1). The higher barley production in 2016 compared to 2015 was due to very high yields this year. The average barley yield in 2016 is estimated at 73.9 bushels per acre compared to 65.0 bushels per acre in 2015 and 62.0 bushels per acre in 2014 (Statistics Canada, CANSIM Table 001-0017).

Barley production in Alberta, including the northeastern part of BC, and in Saskatchewan increased by 2.3% and 17.9%, respectively, compared to last year. In Manitoba, the seeded acreage decreased by 9.9% and the production decreased by 4.6% compared to last year. Figure 2.1 shows annual barley seeded acreage and production in Western Canada since 2006. In 2016, the area seeded with barley was about 17.5% lower than the 10-year average; however, the production of barley was only 1.8% lower than the 10-year average (2006-2015).

Barley is a versatile crop grown for malting, general purpose (feed and forage) and food in a widespread area across the Canadian Prairies. This year in Alberta (including parts of British Columbia), general purpose barley accounted for 55.1% of total barley seeded area compared with malting barley at 43.6% (Fig. 2.2). In Saskatchewan, the majority of seeded area (73.6%) was planted with malting barley varieties (Fig. 2.2). In Manitoba, about 50.3% of barley seeded area was allocated to malting varieties and 47.7% to the general-purpose barley (Fig. 2.2). Overall malting barley accounted for 56.2% of the area seeded with barley in Western Canada compared with general purpose barley at 37.3%. Food barley continued to occupy a relatively small percentage of seeded acres in each province, although this year the production of food barley was higher than last year.

Figure 2.1 Barley production and barley seeded area in Western Canada from 2006 to 2016

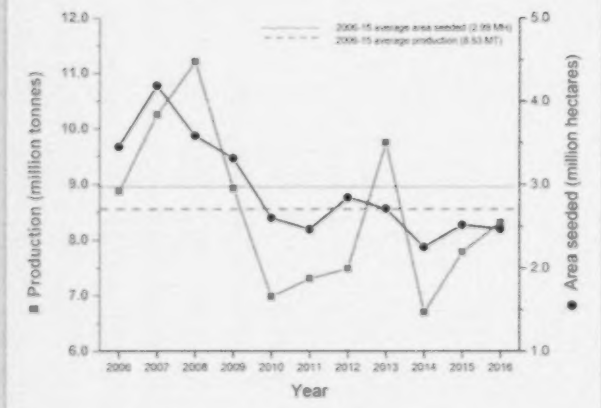


Figure 2.2 Distributions of barley classes as a percentage of total area seeded with barley in Western Canada provinces in 2016

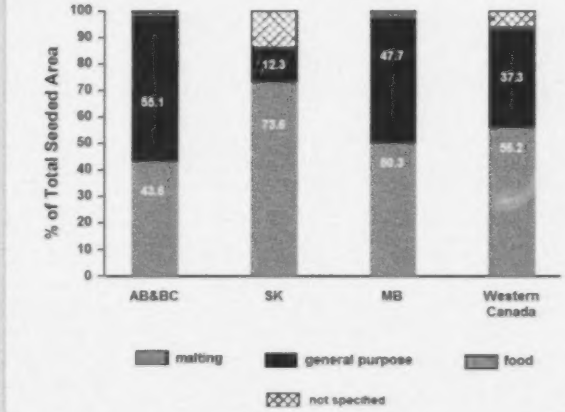


Table 2.1 Yearly comparison of barley seeded area and production in Western Canada[1]

	Seeded area (million hectares)				Production (million tonnes)			
	2016	2015	2014	2006-2015 average	2016	2015	2014	2006-2015 average
Manitoba	0.146	0.162	0.121	0.238	0.540	0.566	0.355	0.730
Saskatchewan	1.002	0.971	0.809	1.175	3.375	2.863	2.173	3.119
Alberta & British Columbia	1.318	1.380	1.317	1.575	4.457	4.357	4.174	4.678
Western Canada	2.465	2.513	2.248	2.988	8.372	7.786	6.702	8.527

[1] Statistics Canada, *CANSIM TABLE 001-0010*, updated December 6, 2016, accessed December 8, 2016

Table 2.2 Distribution of malting barley cultivars as percentage of area seeded with malting barley in Western Canada[1]

Two-Row cultivars (% of area seeded with malting barley in Western Canada)			
	2016	2015	2014
CDC Copeland	44.70	35.38	29.81
AC Metcalfe	34.20	38.50	38.87
AAC Synergy	5.19	0.84	0.21
Newdale	3.07	5.23	5.69
Bentley	2.71	3.35	2.37
CDC Meredith	1.84	5.24	9.81
CDC Kindersley	0.91	1.70	0.95
CDC PolarStar	0.93	1.44	2.05
Merit 57	0.20	0.67	0.65
Merit 16	0.18		
Major	0.13	0.43	0.75
Merit		0.24	
CDC Kendall	0.08	0.16	0.21
Cerveza	0.04	0.02	0.03
Harrington	0.04	0.16	0.27
CDC Bow	0.01		
AAC Connect	0.01		
Other	0.09	0.19	
Total	94.3	93.5	91.6

Six-Row cultivars (% of area seeded with malting barley in Western Canada)			
	2016	2015	2014
Legacy	3.17	3.25	4.45
Celebration	1.17	1.31	1.14
Tradition	0.63	0.90	1.27
Stellar-ND	0.12	0.15	0.50
Lacey	0.11	0.14	0.25
CDC Yorkton	0.11	0.22	0.33
CDC Anderson	0.10	0.07	0.03
Robust	0.09	0.16	0.23
CDC Battleford	0.09	0.13	0.11
Excel	0.04	0.12	0.10
Other	0.03	0.00	
Total	5.7	6.5	8.4

[1] Data Source: Sask Crop Insurance, Alberta Ag Financial Services Corp, Manitoba Management Plus Program, BC Crop Insurance

In 2016, AC Metcalfe and CDC Copeland continued to dominate the portfolio of malting barley cultivars being grown and selected in Western Canada, representing about 78.9% of total area seeded with malting barley (Table 2.2). However, for the first time the area seeded with CDC Copeland significantly exceeded the acreage seeded with AC Metcalfe. In comparison to last year, the acreage seeded with AC Metcalfe in 2016 decreased by 11.2%, whereas the acreage allocated to CDC Copeland increased by 26.3% (Table 2.2). The third most popular variety in 2016 was AAC Synergy whose acreage increased significantly compared to previous years. The area seeded with Newdale, Bentley, and CDC Meredith decreased in 2016 compared to 2015. The area planted with several newer two-row cultivars, including CDC Kindersley, CDC PolarStar, Merit 57, as well as the most recently registered CDC Bow and AAC Connect, remained small, together accounting for less than 2.5% of area seeded with malting barley varieties in Western Canada (Table 2.2).

The production of six-row malting barley continued to decline. In 2016, the six-row cultivars occupied only about 5.7% of the total area seeded with malting barley compared to 6.5% in 2015. Legacy, Celebration and Tradition remained the top three six-row varieties (Table 2.2). Table 2.3 shows the distribution of malting barley cultivars as percentage of area seeded with malting barley in each province. The production of two-row cultivars dominated in Alberta and Saskatchewan with CDC Copeland occupying the largest area in Alberta and AC Metcalfe in Saskatchewan. AAC Synergy prevailed among the two-row varieties seeded in Manitoba, but a relatively large portion of land in Manitoba was also seeded with six-row varieties, especially Celebration and Tradition (Table 2.3).

Table 2.3 Distribution of malting barley cultivars as percentage of area seeded with malting barley in each province in 2016[1]

Two-Row cultivars (% of area seeded with malting barley in Western Canada)			
	AB & BC	SK	MB
CDC Copeland	55.97	38.95	13.00
AC Metcalfe	24.84	43.44	14.40
AAC Synergy	4.54	4.45	18.02
Newdale	3.47	1.75	13.44
Bentley	4.91	0.71	5.61
CDC Meredith	2.17	1.74	0.24
CDC Kindersley	1.36	0.51	1.42
CDC PolarStar	0.18	1.61	0.00
Merit 57	0.49	0.00	0.00
Merit 16	0.37	0.04	0.00
Major	0.18	0.10	0.00
CDC Kendall	0.13	0.05	0.00
Cerveza	0.10	0.00	0.00
Harrington	0.10	0.00	0.00
CDC Bow	0.03	0.00	0.00
AAC Connect	0.01	0.00	0.00
Other	0.14	0.05	0.04
Total	98.97	93.40	66.17

Six-Row cultivars (% of area seeded with malting barley in Western Canada)			
	AB &BC	SK	MB
Legacy	0.27	5.59	1.71
Celebration	0.01	0.39	18.50
Tradition	0.00	0.30	9.14
Stellar-ND	0.00	0.07	1.67
Lacey	0.06	0.00	1.69
CDC Yorkton	0.07	0.11	0.41
Robust	0.05	0.07	0.67
CDC Anderson	0.24	0.00	0.00
CDC Battleford	0.21	0.00	0.01
CDC Kamsack	0.02	0.00	0.00
CDC Mayfair	0.01	0.00	0.00
Excel	0.01	0.07	0.00
Other	0.07	0.00	0.03
Total	1.03	6.60	33.84

[1] Data Source: Sask Crop Insurance, Alberta Ag Financial Services Corp, Manitoba Management Plus Program, BC Crop Insurance

2.2 Recommended Malting Barley Varieties for 2017-18

The Canadian Malting Barley Technical Centre (CMBTC) in collaboration with its member organizations and other industry groups produces an annual Recommended Malting Barley Varieties List which is intended as a guide to assist producers in the selection of varieties for seeding in the coming year.

Two-Row Varieties

VARIETY	MARKET COMMENTS
CDC Copeland[1]	Established Demand
AC Metcalfe[1]	Established Demand
AAC Synergy[4]	Growing Demand
Bentley[2]	Limited Demand
Newdale[3]	Limited Demand
CDC PolarStar[2]	Limited Demand
CDC Kindersley[1]	Under Commercial Market Development

For Bentley or Newdale contracting opportunities contact Canada Malting Company. For CDC PolarStar (and CDC PlatinumStar) contracting opportunities contact Prairie Malt-Cargill.

CMBTC and its members recommend that growers consult with their local malting barley buyer about opportunities in specific areas to grow and market two-row and six-row malting barley varieties, and that certified seeds are used to ensure varietal purity, reduce disease incidence, and increase the likelihood of selection for malt.

Six-Row Varieties

VARIETY	MARKET COMMENTS
Legacy[3]	Limited Demand
Tradition[3]	Limited Demand
Celebration[2]	Limited Demand

New Varieties in Development

The following varieties have been registered with CFIA and are undergoing seed propagation. Both varieties have been pilot tested at the CMBTC and exhibit good quality characteristics suitable for all malt and adjunct brewing styles.

VARIETY	COMMENTS
AAC Connect[2]	Two-Row - Undergoing seed propagation
CDC Bow[1]	Two-Row - Undergoing seed propagation

The following companies have pedigreed seed distribution rights for those varieties that are footnoted:

1 - SeCan	2 - CANTERRA SEEDS
3 - FP Genetics	4 - Syngenta

Part 3 - Annual Harvest Survey

3.1 Sampling and survey methodology

The 2016 malting barley survey was based on 57 varietal composites, representing about one million tonnes of barley selected for domestic malt processing or for export as malting barley by several grain handling and malting companies: Cargill Inc, Canada Malting Co. Ltd., Rahr Malting Co., Richardson International, Viterra Inc., and Malteurop North America Inc. The tonnage included in this survey represents only a portion of the total volume of malting barley selected in Western Canada and does not necessarily reflect the actual amounts selected. Samples were received from the beginning of harvest until the beginning of November 2016. All results presented in this report represent weighted averages based on tonnage of composite samples received and analyzed.

3.2 Quality of barley selected for malting in 2016: general trends and annual statistics

The quality of barley that was selected for malting in 2016 was generally good. The levels of barley proteins in 2016 (11.3%) were substantially lower than in 2015 (12.4%) and lower than the 10-year average (11.7%) (Figure 3.1). Germination energy of barley samples determined during the annual survey was adequate for malting (Figure 3.2); however moderate water sensitivity was present in some samples. This year's barley had very high average 1000 kernel weight (46.5g), higher than in 2015 (45.7g) and higher than the 10-year average (43.2g) (Figure 3.3). Kernel plumpness, a measure of kernels remaining on the 6/64" slotted screen, averaged 93.5%, which is considerably higher than the 10-year average (91.6%) (Figure 3.4). The average kernel diameter and kernel weight were also determined using the Single Kernel Characterization System. The results, presented in Figure 3.5, indicated differences among barley varieties with Bentley and AAC Synergy having bigger and heavier kernels than other varieties tested this year.

Figure 3.1 Average protein content in barley selected for malting from 2006 to 2016

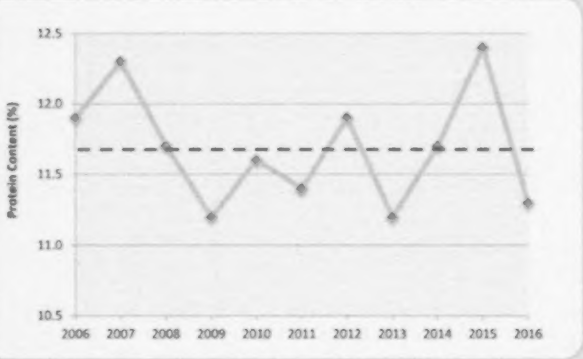
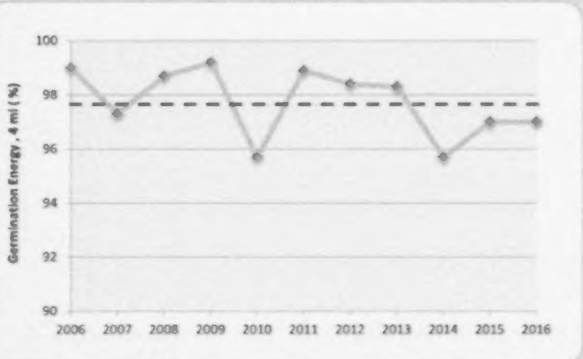


Figure 3.2 Average germination energy of barley selected for malting from 2006 to 2016



Pre-germination is the premature sprouting of grain while still in the ear as a consequence of prolonged spells of wet weather when mature grain remains uncut in the field or swathed and not yet combined; this event is called 'pre-harvest sprouting'. One of the enzymes produced very early during germination is α-amylase. Since the level of α-amylase in sound grain is very low compared to its level in the germinating grain, the content of α-amylase in grain can be used as a marker of germination. Rapid visco analysis (RVA) indirectly estimates the amount of α-amylase in barley by measuring the viscosity of ground barley in water. The results are expressed as viscosity in Rapid Visco Units (RVU) than can be converted to centipoise (cP) (1 RVU = 12 cP).

RVA is used by barley selectors to identify sound, moderately and strongly pre-germinated barley, and to manage their supply accordingly. Samples with final viscosity values > 120 (RVU) are considered sound and the probability that they will retain germination energy (GE) after storage is very high. Samples with RVA values 50-120 (RVU) are moderately pre-germinated, whereas samples with RVA values < 50 (RVU) are substantially

Figure 3.3 Average 1000 kernel weight of barley selected for maiting from 2006 to 2016

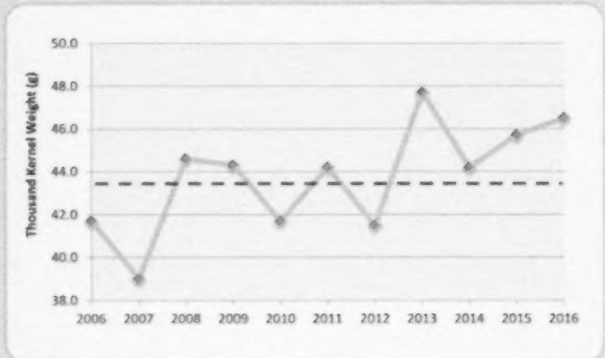


Figure 3.4 Average plumpness of barley selected for malting from 2006 to 2016

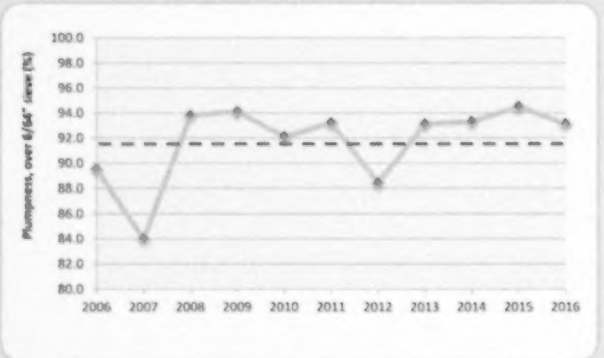
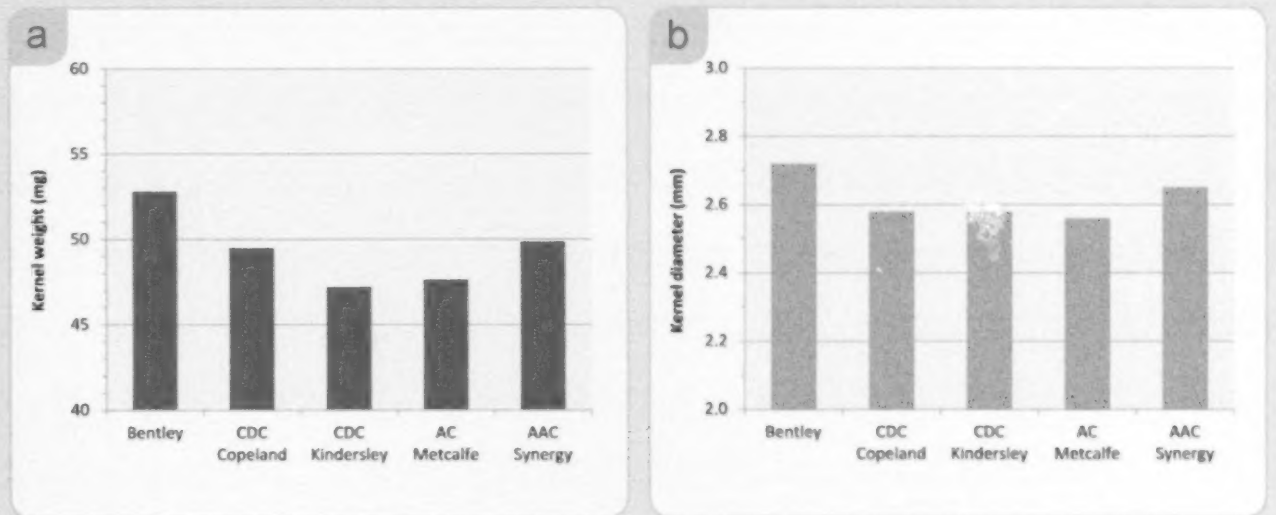


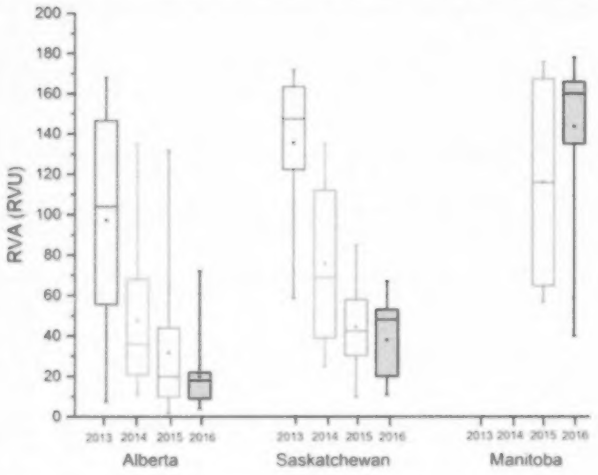
Figure 3.5 Average kernel weight (a) and average kernel diameter (b) for two-row barley cultivars selected for malting in 2016. Kernel weight and diameter values were determined using Single Kernel Characterization System



pre-germinated and the probability that they will lose GE during storage is high. They should be malted as soon as possible. To predict safe storage time more accurately, not only the RVA values, but also the storage conditions (temperature and relative humidity) and the initial moisture content of the grain have to be taken into account.

Among the samples tested in 2016 survey only a few showed high RVA values (>120 RVU). This year's RVA results have reflected wet harvest conditions, especially in Alberta and Saskatchewan, resulting in high incidence of substantial pre-germination (<50 RVU), similar to 2014 and 2015, but dramatically different from dry harvest conditions in 2013 (Figure 3.6). The RVA results stress the need for identification of barley with low RVU that should be malted promptly, especially if the moisture content of grain is relatively high. As indicated in the next sections of this report, pre-germinated barley malted soon after harvest can produce good quality malt.

Figure 3.6 RVA results for barley selected for malting in 2016 in comparison with previous years[1]



Risk of germination loss in storage	RVA Viscosity (RVU)
Low	≥120
Intermediate	50-120
High	<50

[1]The boxes in the graph shows the range of RVA values in the middle 50% of the analyzed samples; the horizontal line and the dot inside the box indicate the median and mean, respectively. The short horizontal lines outside of the box mark the minimum and maximum values.

3.3 Malting conditions and methodologies

Initial malting trials indicated that sufficient steep out moisture levels were achieved using two wet steep cycles. Despite relatively large kernel weight and diameter, kernels took up water easily with total wet steep time of 12 hours. All analytical methods used in this survey to assess the barley, malt and wort quality are listed in the Appendix I.

Table 3.1 Malting conditions used with GRL Phoenix Micromalting System in 2016

Steeping	8 hours wet steep, 16 hours air rest, 4 hours wet steep, 16 hours air rest @ 13°C
Germination	96 hours @ 15°C
Kilning	12 hours @ 60°C, 6 hours@ 65°C, 2 hours @ 75°C, 4 hours @ 85°C

3.4 Malting quality in 2016 - Highlights

- The selection of barley for malting purposes in 2016 was challenged by the above normal rainfall through July and August, which increased disease potential in the barley crop, and by wet harvest conditions, which increased the incidence of pre-harvest sprouting. However, the quality of barley that was selected for malting was good.
- Protein levels in barley grain were substantially lower than in 2015 and lower than the long-term average values.
- Thousand kernel weights and kernel plumpness levels were higher than the long-term averages.
- Barley germination was adequate; however, some water sensitivity was present.
- Malt made from 2016 barley resulted in record high extract levels surpassing the long-term average values.
- Wort was characterized by slightly higher than average levels of β-glucans, but acceptable wort viscosity, and lower than average levels of soluble proteins, free amino nitrogen (FAN), and colour.
- Production of good quality malt from the 2016 barley crop is achievable through diligent barley selection and timely processing.

Part 4 - Quality data for individual varieties

CDC Copeland

In 2016, CDC Copeland became the dominant malting barley variety grown in Western Canada. Its excellent brewing characteristics combined with lower protein and enzyme levels, provides an excellent balance within the portfolio of malting barley varieties.

Figure 1. Percentage of the total malting barley area in Western Canada seeded with CDC Copeland in 2016 compared to 2015

Figure 2. Average protein content in CDC Copeland selected for malting from 2010-2016

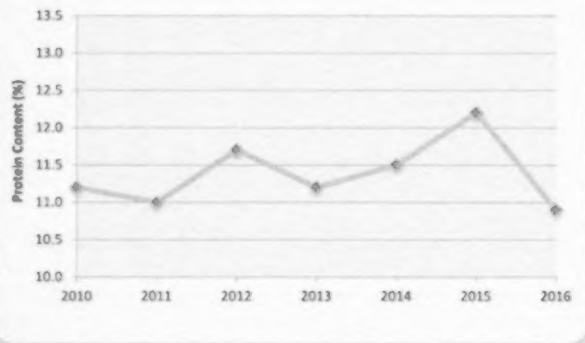


Figure 3. Average 1000 kernel weight of CDC Copeland selected for malting from 2010-2016

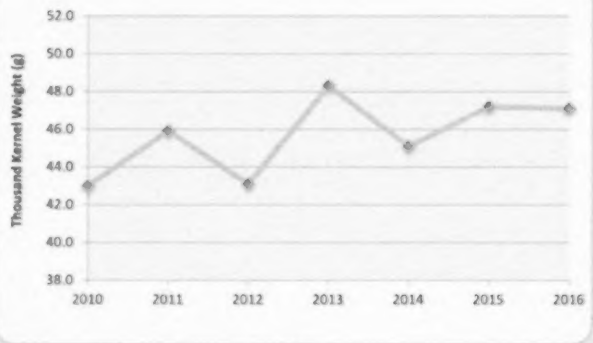


Figure 4. Comparison of average levels of extract by variety in 2016

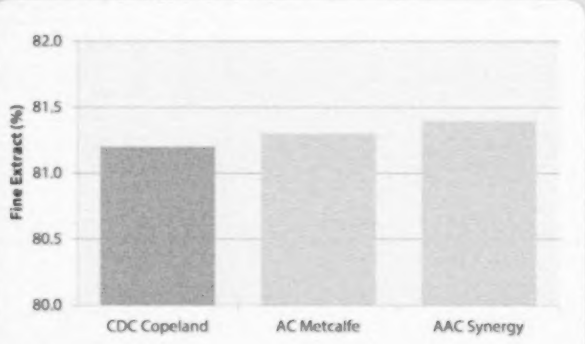


Figure 5. Comparison of average levels of diastatic power by variety in 2016

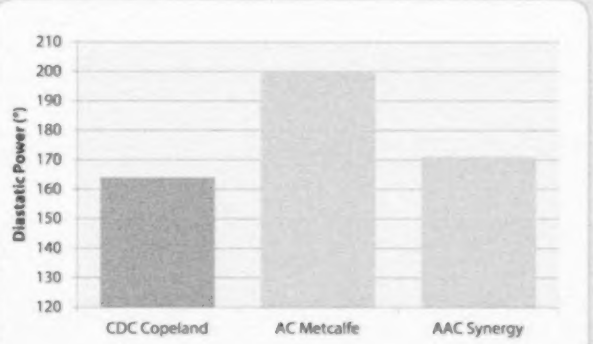


Table 4.1 Quality data for 2016 harvest survey composite samples of CDC Copeland malting barley[1]

Origin of selected samples	Alberta		Saskatchewan		Manitoba	Prairie Provinces		
Crop year	**2016**	2015	**2016**	2015	**2016**	**2016**	2015	2011-2015 Average
Tonnage[2], thousand of tonnes	481	261	232	290	38	761	551	336
Barley								
Test weight, kg/hL	**66.1**	66.2	**65.3**	66.4	66.2	**65.8**	66.3	66.2
1000 Kernel weight, g	**47.9**	47.6	**46.0**	46.8	44.0	**47.1**	47.2	45.9
Plump, over 6/64" sieve, %	**93.7**	96.1	**92.8**	94.9	90.7	**93.3**	95.4	92.9
Intermediate, over 5/64"sieve, %	**4.3**	2.9	**4.9**	3.7	6.8	**4.6**	3.3	5.3
Moisture[3], %	**13.1**	12.1	**12.6**	12.7	11.9	**12.9**	12.4	12.0
Protein, %	**10.8**	12.2	**11.0**	12.3	11.1	**10.9**	12.2	11.5
Germination, 4 ml (3 day), %	**97**	97	**97**	97	98	**97**	97	97
Germination, 8 ml (3 day), %	**90**	94	**91**	86	93	**90**	90	91
Malt								
Yield, %	**92.1**	90.8	**91.3**	90.6	92.1	**91.8**	90.7	91.9
Steep-out moisture, %	**44.9**	44.9	**45.3**	45.3	44.0	**45.0**	45.1	44.3
Friability, %	**75.9**	73.9	**76.6**	74.6	83.3	**76.4**	74.2	78.3
Moisture, %	**6.1**	5.3	**6.3**	5.3	5.7	**6.2**	5.3	5.1
Diastatic power, °	**161**	171	**170**	174	164	**164**	172	146
α-Amylase, D.U.	**70.5**	73.3	**76.2**	76.0	79.4	**72.6**	74.7	56.8
Wort								
Fine grind extract, %	**81.1**	80.2	**81.1**	80.3	81.8	**81.2**	80.2	80.6
Coarse grind extract, %	**80.5**	79.3	**80.7**	79.6	80.9	**80.6**	79.4	79.7
F/C difference, %	**0.6**	0.9	**0.5**	0.7	0.9	**0.6**	0.8	0.8
ß-Glucan, ppm	**105**	48	**69**	41	68	**92**	44	65
Viscosity, cP	**1.43**	1.43	**1.41**	1.43	1.42	**1.42**	1.43	1.43
Soluble protein, %	**4.39**	4.73	**4.75**	5.11	4.92	**4.52**	4.93	4.88
Ratio S/T, %	**40.1**	39.6	**41.9**	42.7	43.9	**40.8**	41.2	42.0
FAN, mg/L	**202**	217	**223**	234	234	**209**	226	205
Colour, ASBC units	**1.91**	2.06	**2.32**	2.31	2.17	**2.04**	2.19	2.19

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of samples represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

AC Metcalfe

In 2016, AC Metcalfe occupied the second largest area seeded with malting barley on the Prairies. Despite slightly lower production of AC Metcalfe in 2016 compared to 2015, this variety continues to be one of the most dominant malting barley variety grown in Western Canada. With high levels of extract and diastatic enzymes, its reputation for excellent brewing performance generates strong demand from both domestic and export markets.

Figure 1. Percentage of the total malting barley area in Western Canada seeded with AC Metcalfe in 2016 compared to 2015

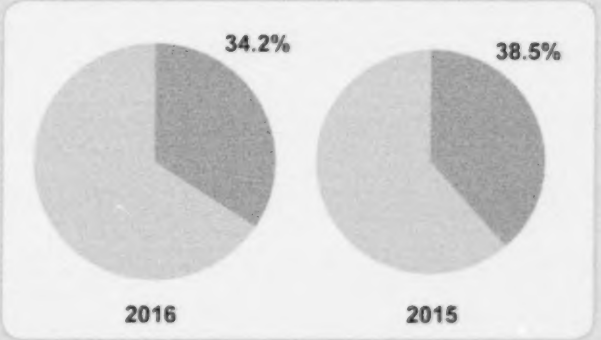


Figure 2. Average protein content in AC Metcalfe selected for malting from 2010-2016

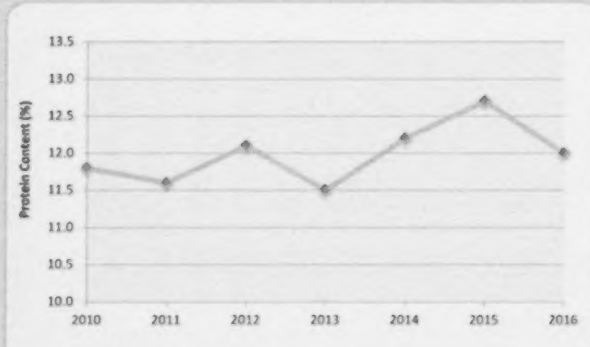


Figure 3. Average 1000 kernel weight of AC Metcalfe selected for malting from 2010-2016

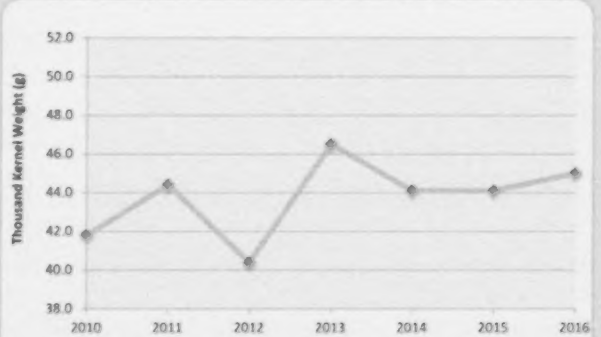


Figure 4. Comparison of average levels of extract by variety in 2016

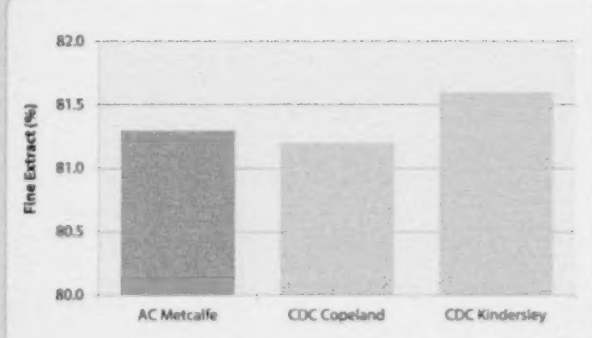


Figure 5. Comparison of average levels of diastatic power by variety in 2016

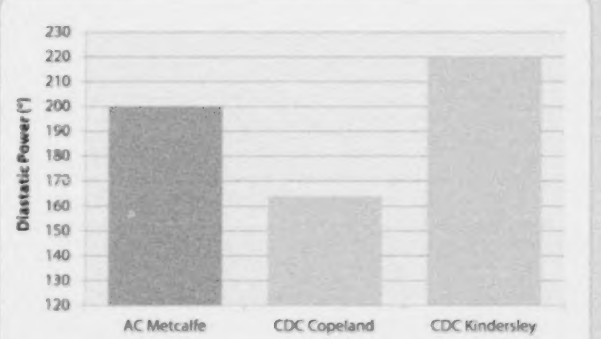


Table 4.2 Quality data for 2016 harvest survey composite samples of AC Metcalfe malting barley[1]

Origin of selected samples	Alberta		Saskatchewan		Manitoba	Prairie Provinces		
Crop year	2016	2015	2016	2015	2016	2016	2015	2011-2015 Average
Tonnage[2], thousand of tonnes	131	247	226	198	9.7	366	445	362
Barley								
Test weight, kg/hL	67.7	67.7	68.0	67.2	67.3	67.8	67.5	67.5
1000 Kernel weight, g	45.6	44.7	44.8	43.5	42.7	45.0	44.1	43.9
Plump, over 6/64" sieve, %	93.0	93.4	92.2	92.8	88.9	92.4	93.1	92.1
Intermediate, over 5/64"sieve, %	4.8	4.9	5.5	5.5	8.0	5.3	5.2	5.8
Moisture[3], %	12.8	11.9	12.7	11.9	11.6	12.7	11.9	11.7
Protein, %	12.0	12.7	12.1	12.6	12.1	12.0	12.7	12.0
Germination, 4 ml (3 day), %	98	96	98	96	97	98	96	98
Germination, 8 ml (3 day), %	92	85	86	80	83	88	83	88
Malt								
Yield, %	91.1	90.2	91.2	89.7	92.3	91.2	90.0	91.3
Steep-out moisture, %	45.2	45.2	44.9	45.6	44.5	45.0	45.4	44.6
Friability, %	59.2	61.9	61.8	64.3	71.1	61.1	63.0	70.5
Moisture, %	6.4	5.2	6.5	5.1	4.9	6.4	5.2	5.1
Diastatic power, °	199	190	201	188	175	200	189	169
α-Amylase, D.U.	100.2	92.0	100.3	92.1	94.7	100.1	92.0	75.1
Wort								
Fine grind extract, %	81.1	80.6	81.4	80.5	81.5	81.3	80.5	80.8
Coarse grind extract, %	80.5	79.8	80.6	79.8	80.8	80.6	79.8	79.9
F/C difference, %	0.5	0.8	0.8	0.6	0.7	0.7	0.7	0.7
ß-Glucan, ppm	98	40	102	34	163	102	38	64
Viscosity, cP	1.42	1.43	1.42	1.42	1.44	1.42	1.42	1.43
Soluble protein, %	4.77	5.16	4.83	5.39	4.79	4.81	5.26	4.95
Ratio S/T, %	40.5	41.7	40.8	43.8	40.6	40.7	42.6	41.2
FAN, mg/L	222	248	229	258	241	227	253	215
Colour, ASBC units	1.93	2.30	1.42	2.52	2.22	2.07	2.40	2.15

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of samples represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

AAC Synergy

In 2016, AAC Synergy became the third most popular variety grown on the Prairies. AAC Synergy is a newer high yielding variety with relatively high kernel weight and plumpness. AAC Synergy is characterized by relatively low grain protein content. AAC Synergy has a desirable malting quality profile with high malt extract, good protein modification, low levels of wort beta-glucans, and intermediate levels of starch-degrading enzymes. Overall, AAC Synergy's excellent combination of agronomic traits, disease resistance and malting quality make it a desirable two-row malting barley variety for western Canadian producers and the malting and brewing industry.

Figure 1. Percentage of the total malting barley area in Western Canada seeded with AAC Synergy in 2016 compared to 2015

Figure 2. Average protein content in AAC Synergy selected for malting in 2015 and 2016

Figure 3. Average 1000 kernel weight of AAC Synergy selected for malting in 2015 and 2016

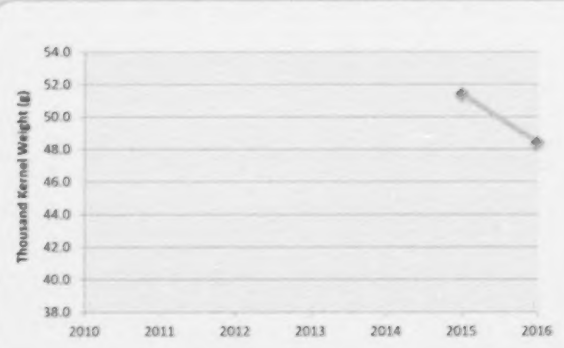


Figure 4. Comparison of average levels of extract by variety in 2016

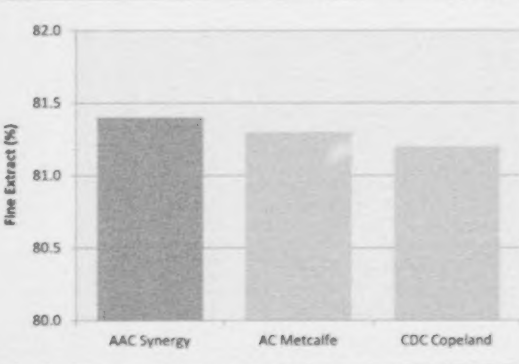


Figure 5. Comparison of average levels of diastatic power by variety in 2016

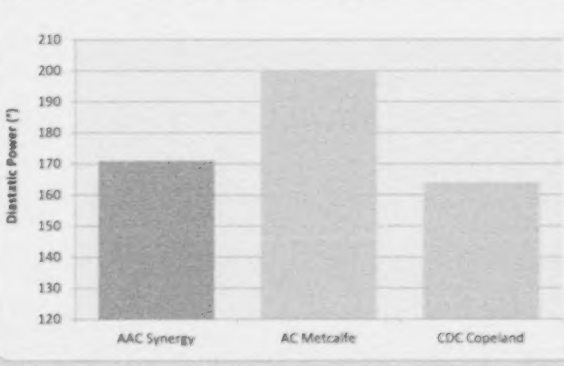


Table 4.3 Quality data for 2016 harvest survey composite samples of AAC Synergy malting barley[1]

Origin of selected samples	Prairie Provinces	
Crop year	2016	2015
Tonnage[2], thousand of tonnes	44	8.1
Barley		
Test weight, kg/hL	64.4	66.7
1000 Kernel weight, g	48.4	51.4
Plump, over 6/64" sieve, %	96.3	97.2
Intermediate, over 5/64"sieve, %	2.2	1.6
Moisture[3], %	13.4	12.6
Protein, %	10.9	11.5
Germination, 4 ml (3 day), %	99	99
Germination, 8 ml (3 day), %	86	95
Malt		
Yield, %	91.1	90.5
Steep-out moisture, %	45.9	45.4
Friability, %	75.5	72.4
Moisture, %	5.8	5.2
Diastatic power, °	171	153
α-Amylase, D.U.	85.7	80.1
Wort		
Fine grind extract, %	81.4	81.3
Coarse grind extract, %	81.0	80.3
F/C difference, %	0.4	1.0
ß-Glucan, ppm	49	25
Viscosity, cP	1.40	1.41
Soluble protein, %	4.43	4.58
Ratio S/T, %	41.4	42.0
FAN, mg/L	202	212
Colour, ASBC units	1.91	1.96

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of samples represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

Bentley

The area seeded with Bentley decreased slightly in 2016 compared to 2015; however, still significant quantities were grown and selected in 2016. With high yields and good disease resistance, Bentley is an attractive choice for producers. Bentley's consistently large kernels have the potential to deliver high levels of extract.

Figure 1. Percentage of the total malting barley area in Western Canada seeded with Bentley in 2016 compared to 2015

Figure 2. Average protein content in Bentley selected for malting from 2011-2016

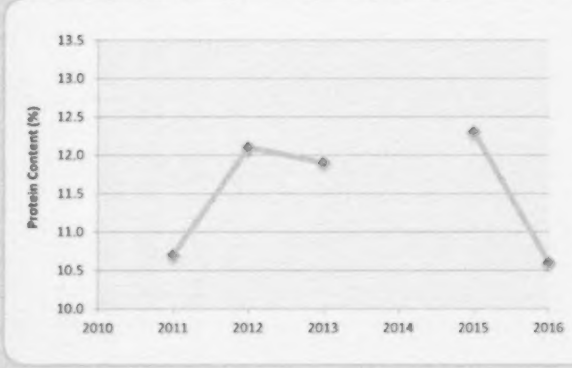


Figure 3. Average 1000 kernel weight of Bentley selected for malting from 2011-2016

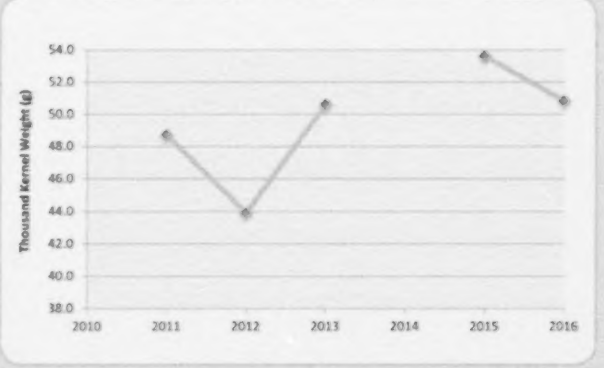


Figure 4. Comparison of average levels of extract by variety in 2016

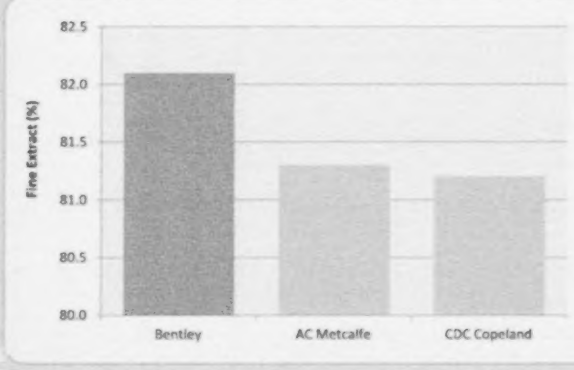


Figure 5. Comparison of average levels of diastatic power by variety in 2016

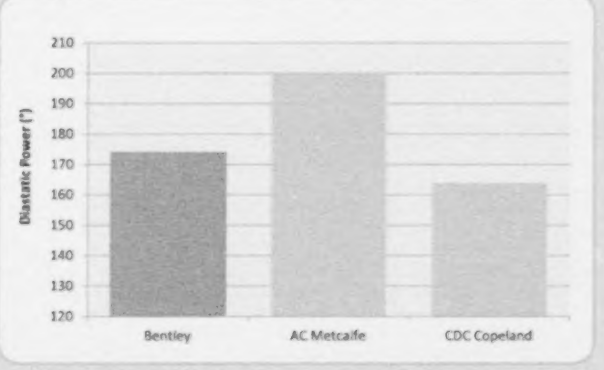


Table 4.4 Quality data for 2016 harvest survey composite samples of Bentley malting barley[1]

Origin of selected samples	Prairie Provinces		
Crop year[2]	**2016**	2015	2012-2015 Average
Tonnage[3], thousand of tonnes	9.0	6.3	5.8
Barley			
Test weight, kg/hL	**67.4**	64.5	63.9
1000 Kernel weight, g	**50.8**	53.6	49.4
Plump, over 6/64" sieve, %	**96.1**	96.7	93.6
Intermediate, over 5/64"sieve, %	**1.5**	1.5	4.1
Moisture[4], %	**13.4**	14.0	13.5
Protein, %	**10.6**	12.3	12.1
Germination, 4 ml (3 day), %	**99**	94	95
Germination, 8 ml (3 day), %	**84**	82	80
Malt			
Yield, %	**91.6**	91.0	90.3
Steep-out moisture, %	**44.8**	45.8	45.9
Friability, %	**75.5**	60.5	71.4
Moisture, %	**6.2**	5.7	5.4
Diastatic power, °	**174**	170	159
α-Amylase, D.U.	**78.7**	61.2	61.8
Wort			
Fine grind extract, %	**82.1**	80.5	80.6
Coarse grind extract, %	**81.8**	80.2	80.2
F/C difference, %	**0.3**	0.3	0.4
ß-Glucan, ppm	**86**	41	42
Viscosity, cP	**1.43**	1.44	1.42
Soluble protein, %	**4.43**	5.11	5.06
Ratio S/T, %	**43.0**	42.0	42.0
FAN, mg/L	**208**	244	232
Colour, ASBC units	**1.74**	2.35	2.40

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Bentley not included in 2014 Harvest Survey due to lack of sufficient number of samples.

[3] Indicates weight of samples represented in this survey; does not represent amounts commercially selected.

[4] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

CDC Kindersley

CDC Kindersley is a newer early maturing, high yielding variety descended from CDC Kendall. CDC Kindersley modifies easily, resulting in high friability values and low levels of wort β-glucan. Its relatively high FAN and enzyme levels make it well suited for adjunct or high gravity brewing.

Figure 1. Percentage of the total malting barley area in Western Canada seeded with CDC Kindersley in 2016 compared to 2015

Figure 2. Average protein content in CDC Kindersley selected for malting from 2012-2016

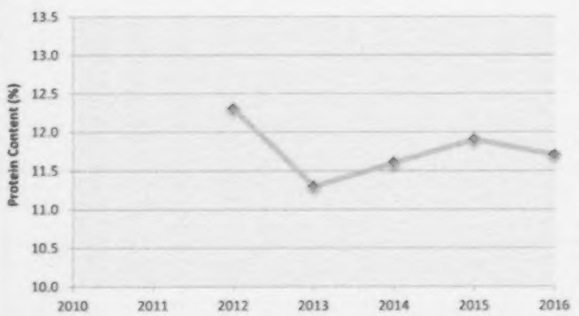


Figure 3. Average 1000 kernel weight of CDC Kindersley selected for malting from 2012-2016

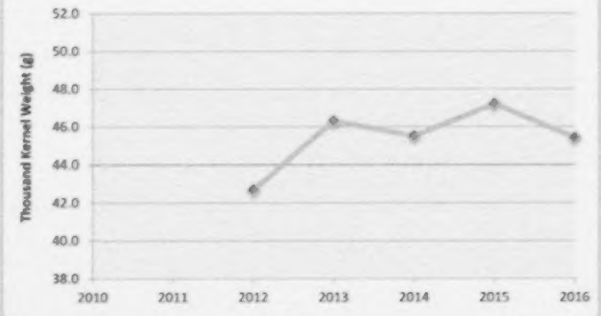


Figure 4. Comparison of average levels of extract by variety in 2016

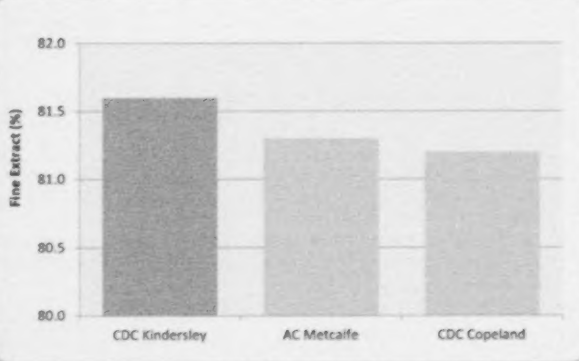


Figure 5. Comparison of average levels of diastatic power by variety in 2016

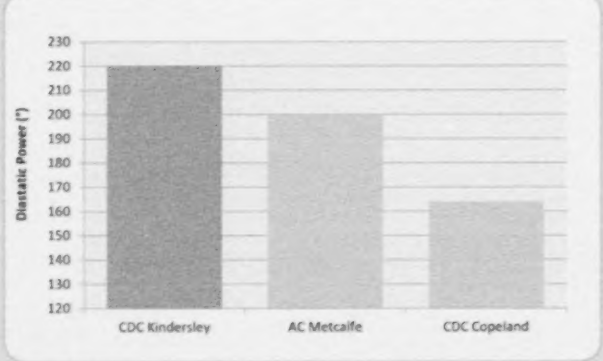


Table 4.5 Quality data for 2016 harvest survey composite samples of CDC Kindersley malting barley[1]

Origin of selected samples	Prairie Provinces		
Crop year	**2016**	2015	2012-2015 Average
Tonnage[2], thousand of tonnes	2.8	4.2	7.6
Barley			
Test weight, kg/hL	**66.8**	66.5	67
1000 Kernel weight, g	**45.4**	47.2	45.4
Plump, over 6/64" sieve, %	**92.8**	96.7	93.8
Intermediate, over 5/64"sieve, %	**5.0**	2.2	4.4
Moisture[3], %	**13.6**	13.4	12.7
Protein, %	**11.7**	11.9	11.8
Germination, 4 ml (3 day), %	**91**	94	95
Germination, 8 ml (3 day), %	**88**	82	89
Malt			
Yield, %	**90.2**	90.5	90.3
Steep-out moisture, %	**45.5**	46.6	45.9
Friability, %	**65.8**	66.8	74.1
Moisture, %	**6.3**	5.6	5.3
Diastatic power, °	**220**	201	190
α-Amylase, D.U.	**94.7**	69.4	68.7
Wort			
Fine grind extract, %	**81.6**	80.9	80.7
Coarse grind extract, %	**81.2**	80.6	80.3
F/C difference, %	**0.4**	0.4	0.5
ß-Glucan, ppm	**39**	24	39
Viscosity, cP	**1.40**	1.43	1.41
Soluble protein, %	**5.83**	5.58	5.28
Ratio S/T, %	**49.6**	46.2	44.7
FAN, mg/L	**285**	269	230
Colour, ASBC units	**2.80**	2.81	2.45

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of samples represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

Legacy

While acreage seeded with six-row malting barley is in decline, small amounts of Legacy barley continue to be grown and selected. Legacy's high enzyme package makes it ideal for high gravity or adjunct brewing.

Figure 1. Percentage of the total malting barley area in Western Canada seeded with Legacy in 2016 compared to 2015

Figure 2. Average protein content in Legacy selected for malting from 2010-2016

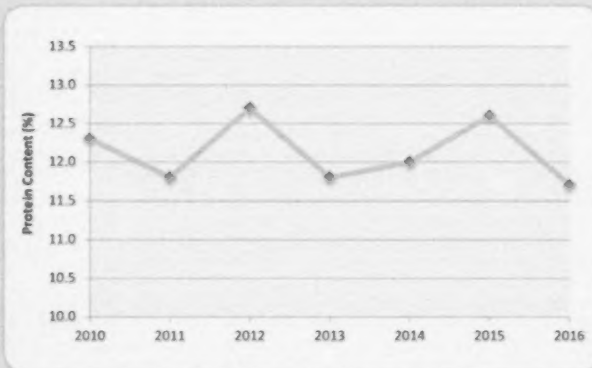


Figure 3. Average 1000 kernel weight of Legacy selected for malting from 2010-2016

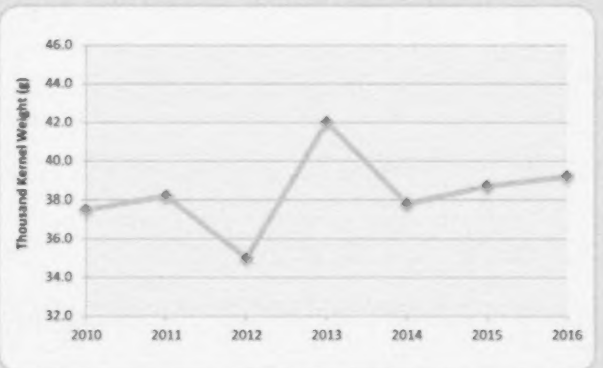


Figure 4. Comparison of average levels of extract by variety in 2016

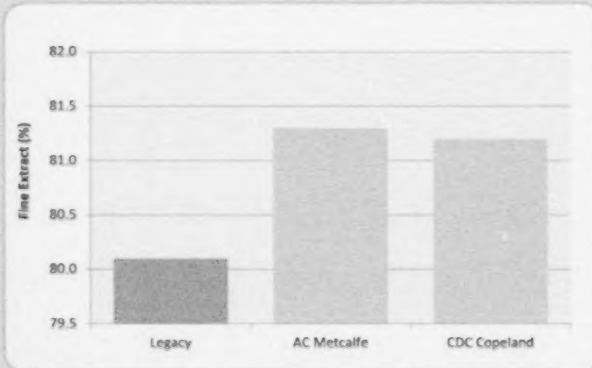


Figure 5. Comparison of average levels of diastatic power by variety in 2016

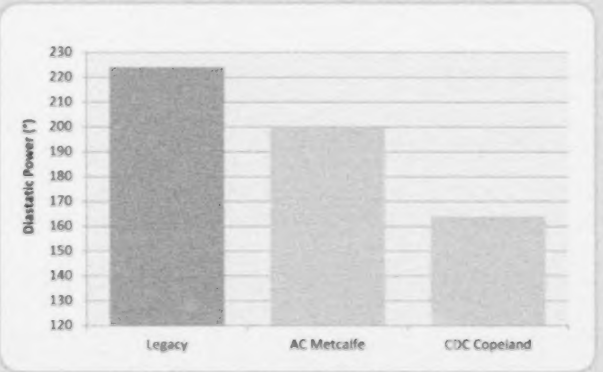


Table 4.6 Quality data for 2016 harvest survey composite samples of Legacy malting barley[1]

Origin of selected samples	Prairie Provinces		
Crop year	**2016**	2015	2011-2015 Average
Tonnage[2], thousand of tonnes	43	45	43
Barley			
Test weight, kg/hL	**64.1**	63.9	64.7
1000 Kernel weight, g	**39.2**	38.7	38.4
Plump, over 6/64" sieve, %	**94.3**	94.1	92.9
Intermediate, over 5/64"sieve, %	**3.7**	4.6	5.0
Moisture[3], %	**15.0**	11.4	11.0
Protein, %	**11.7**	12.6	12.2
Germination, 4 ml (3 day), %	**98**	100	96
Germination, 8 ml (3 day), %	**81**	79	78
Malt			
Yield, %	**92.0**	91.1	92.2
Steep-out moisture, %	**43.9**	44.8	44.3
Friability, %	**65.8**	72.1	71.8
Moisture, %	**5.9**	5.8	5.2
Diastatic power, °	**224**	232	188
α-Amylase, D.U.	**94.0**	90.4	67.5
Wort			
Fine grind extract, %	**80.1**	79.3	79.5
Coarse grind extract, %	**79.3**	78.2	78.3
F/C difference, %	**0.8**	1.1	1.0
ß-Glucan, ppm	**269**	173	199
Viscosity, cP	**1.42**	1.43	1.45
Soluble protein, %	**5.11**	5.28	5.36
Ratio S/T, %	**44.6**	43.7	44.5
FAN, mg/L	**259**	250	234
Colour, ASBC units	**2.21**	1.99	2.33

[1] Values represent weighted averages based on tonnage of composite samples received.

[2] Indicates weight of samples represented in this survey; does not represent amounts commercially selected.

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

Part 5 - Brewing trials in 2016

Brewing trials conducted by the CMBTC according to standard brewing conditions[1] indicated that malts made from CDC Copeland and AC Metcalfe performed satisfactorily without posing any specific processing difficulties.

CDC Copeland exhibited comparable conversion time and slightly longer lautering time, but similar brewhouse efficiency compared with 2015 malt (Table 5.1). The average wort colour was lighter than last year. The high attenuation limit indicated excellent fermentability of CDC Copeland malt in 2016.

AC Metcalfe exhibited similar conversion time, slightly longer lautering time and lower brewhouse efficiency compared to 2015 malt (Table 5.2). The average wort colour was lighter than last year. The high attenuation limit indicated good fermentability of AC Metcalfe malt in 2016, which was comparable to 2015.

Table 5.1 Brewhouse performance of CDC Copeland in pilot brewing trials.

Brewing Parameters	CDC Copeland	
	2016[a]	2015
Conversion time (min.)	16	16
Time to clear (min.)	7	5
Lautering time (min.)	49	46
Brewhouse Efficiency (%)	87.8	88
Wort pH	5.34	5.51
Wort Colour (SRM)	3.89	4.37
Attenuation Limit (%)	88.9	87.6

[a] Average values of 4 brewing trials performed with malt from 2016 crop

Table 5.2 Brewhouse performance of AC Metcalfe in pilot brewing trials.

Brewing Parameters	AC Metcalfe	
	2016[a]	2015
Conversion time (min.)	12	12
Time to clear (min.)	7	7
Lautering time (min.)	49	45
Brewhouse Efficiency (%)	86.5	88.5
Wort pH	5.3	5.37
Wort Colour (SRM)	4.42	5.57
Attenuation Limit (%)	84.9	85

[a] Average values of 5 brewing trials performed with malt from 2016 crop

[1]Brewing Conditions

1. 100% all malt brew with 40 kg of malt (water to malt ratio of 3.75:1)
2. Mashing: mash in at 48°C; 30-minute hold; temperature raise at 1.5°C per minute to 65°C; 30-minute hold (iodine conversion test every minute); temperature raise at 1.5°C per minute to 77°C; one-minute hold. Transfer mash to lauter tun with 25L underlet water.
3. 10-minute rest in lauter tun followed by a vorlauf (wort clarification) until wort clarity reading is below 100 FTU. First wort collected into kettle followed by a hot water sparge of the grain bed using 125L of water at 77°C to a total volume of 275L in brew kettle.
4. Boil for 90 minutes with 9% evaporation rate. Hop additions of Nugget at 0 minutes into boil time and Mt. Hood at 85 minutes into boil time.
5. Cool wort and force ferment overnight using 600ml of wort and 120g of lager yeast slurry.

Appendix I - Methods

This section describes methods used at the Grain Research Laboratory. Unless otherwise specified, analytical results for barley and malt are reported on a dry weight basis.

α-Amylase activity

α-Amylase activity is determined according to ASBC method MALT 7B by segmented flow analysis, using ASBC dextrinized starch as the substrate, and calibrated with standards that have been determined by method ASBC Malt 7A.

Assortment

All samples are passed through a Carter Dockage Tester equipped with a No. 6 riddle to remove foreign material and two slotted sieves to sort the barley. plump barley is the material retained on a 6/64" (2.38 mm) x 3/4" slotted sieve.

Intermediate Grade is barley that passes through the 6/64" x 3/4" sieve but is retained on a 5/64" (1.98 mm) x 3/4" slotted sieve.

β-Glucan content

β-Glucan content is determined in malt extract by segmented flow analysis using Calcofluor staining of soluble, high molecular weight ß-glucan (ASBC Wort-18B).

Diastatic power

Diastatic power is determined by segemented flow analysis, using an automated neocuproin assay for reducing sugars, which is calibrated using malt standards analysed using the official ferricyanide reducing sugar method, (ASBC Malt 6A).

Fine-grind and coarse-grind extracts

Extracts are prepared using an Industrial Equipment Corporation (IEC) mash bath and the Congress mashing procedure from 45°C to 70°C. Specific gravities are determined at 20°C with an Anton Paar DMA 5000M digital density meter (ASBC Malt-4).

Free Amino Nitrogen (FAN)

Free amino nitrogen is determined on the fine extract according to the official ASBC method Wort-12 by segmented flow analysis.

Germination energy

Germination energy is determined by placing 100 kernels of barley on two layers of Whatman #1 filter paper, in a 9.0 cm diameter petri dish, and adding 4.0 ml of purified water. Samples are controlled at 20 degrees Celcius and 90% relative humidity in a germination chamber. Germinated kernels are removed after 24 and 48 hours and a final count is made at 72 hours (ASBC Barley 3C).

Kolbach index (ratio S/T)

Kolbach index is calculated from the formula, (% Soluble protein/% Malt protein) x 100.

Micromalting

Malts are prepared using an Automated Phoenix Micromalting System designed to handle twenty-four 500 g samples of barley per batch.

Malt mills

Fine-grind malt is prepared with a Buhler-Miag disc mill set to fine-grind. Coarse-grind malt is prepared with the same mill set to coarse-grind. The settings for fine- and coarse-grinds are calibrated quarterly, based on the screening of a ground ASBC standard check malt (ASBC Malt-4).

Moisture content of barley

Moisture content of barley is predicted using NIR equipment that has been calibrated by the standard ASBC method (ASBC Barley 5C).

Moisture content of malt

Moisture content of malt is determined on a ground sample by oven drying at 104°C for 3 hours (ASBC Malt-3).

Protein content (N x 6.25)

Protein content is predicted on dockage-free barley using NIR equipment that has been calibrated by Combustion Nitrogen Analysis (CNA). CNA is determined on a LECO Model FP-428 CNA analyser calibrated by EDTA. Samples are ground on a UDY Cyclone Sample Mill fitted with a 1.0-mm screen. A 200-mg sample is analysed as received (it is not dried prior to analysis). A moisture analysis is also performed and results are reported on a dry matter basis (ASBC Barley 7C).

Rapid Viscometric Analysis

The degree of pre-germination in barley was determined as described by Izydorczyk (2005); see the CGC website at http://www.grainscanada.gc.ca/research-recherche/izydorczyk/rva/rva-eng.htm. Samples were analyzed using the RVA-4 (Newport Scientific) and the Stirring Number Program. Final viscosity values were presented in Rapid Visco Units (RVU).

Viscosity

Viscosity is measured on fine grind Congress wort using an Anton Paar Lovis 2000 automated rolling ball viscometer (ASBC Wort-13B).

Water sensitivity

Water sensitivity is determined exactly as described for germination energy, except that 8.0 ml of purified water is added to each petri dish (ASBC 3C, IOB and EBC procedure). The water sensitivity value is the numerical difference between the 4ml and 8ml tests.

Weight per thousand kernels

A 500 gram sample of dockage-free barley is divided several times in a mechanical divider to obtain one representative 40g sub-sample. All foreign material and broken kernels are removed from one 40 gram portion and the net weight determined. The number of kernels is then counted with a mechanical counter and thousand kernel weight is calculated (as is basis) (Institute of Brewing's Recommended Methods of Analysis, Barley 1.3 (1997)).

Wort-soluble protein

Wort-soluble protein is determined spectrophotometrically using ASBC method Wort-17.

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